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AN INTRODUCTION OF HOKUTO MEGA-SOLAR PROJECT AND SOME RESULTS IN THE FIRST STAGE

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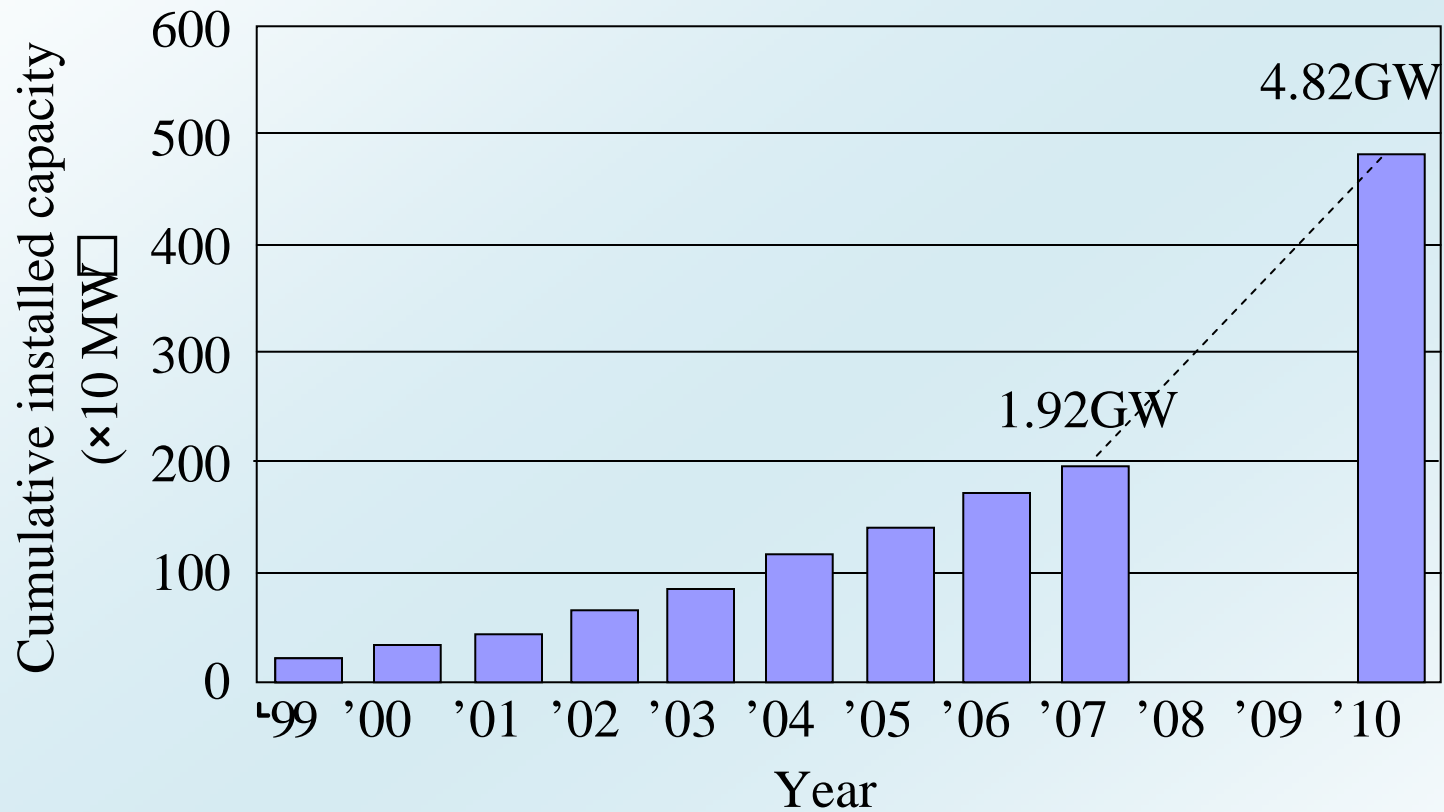
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INTRODUCTION

- Solar generation systems are one of the measures for reducing global warming.
- An installed capacity target of solar generation systems in our country will be set 4.82GW in 2010.
- NEDO advertised for consignment research business
“Verification of Grid Stabilization with Large-scale Photovoltaic (PV) Power Generation Systems”
in 2006.
- The verification tests are carried out in two sites of Hokuto City, Yamanashi Prefecture and Wakkanai City, Hokkaido.
- The outlines and the developing targets and studying/measured results of the Hokuto Mega-solar project (HMP) are introduced.



Installed capacity and target

Source

Ministry of Economy, Trade and Industry : Advisory Committee for Energy (May 2001)

Natural Resources and Energy Agency : 2000,2001,2002,2003,2004

Japan Photovoltaic Energy Association : Photovoltaic Power Generation (2005)

New Energy and Industrial Technology Development Organization: Wind force Power Generation (2006)

FY2005 and Earlier

FY2006

FY2007

FY2008 and After

Demonstrative Project of Facilitated Connection (FY1998-2003)



Demonstrative Project on Grid-Interconnection of Clustered Photovoltaic Power Generation Systems (FY2002-2007)



Wind Power Stabilization Technology Development Project (FY2003-2007)



Demonstrative Project of Regional Power Grid with Various New Energies (FY2003-2007)

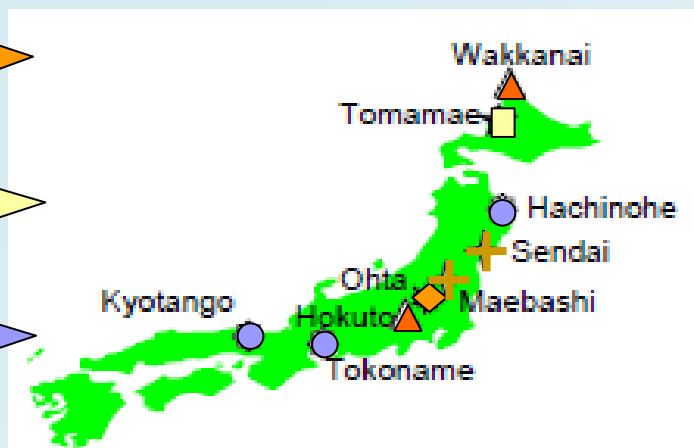


Demonstrative Project on New Power Network Systems (FY2004-2007)



Verification of Grid Stabilization with Large-Scale PV Power Generation Systems (FY2006-2010)

Development of Electric Energy Storage System for Grid-connection with New Energy Resources (FY2006-2010)

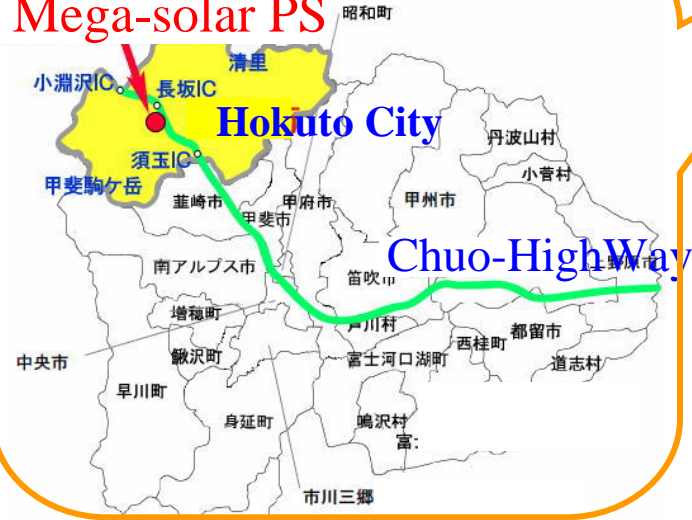


NEDO's grid connection system projects



- Installed capacity: nearly 2MW
- Area: 95,656m²
- Developing period: 2006-2010
- Location: Hokuto city,
Yamanashi Prefecture

Mega-solar PS



Yatsugatake mountains

Chuo High Way

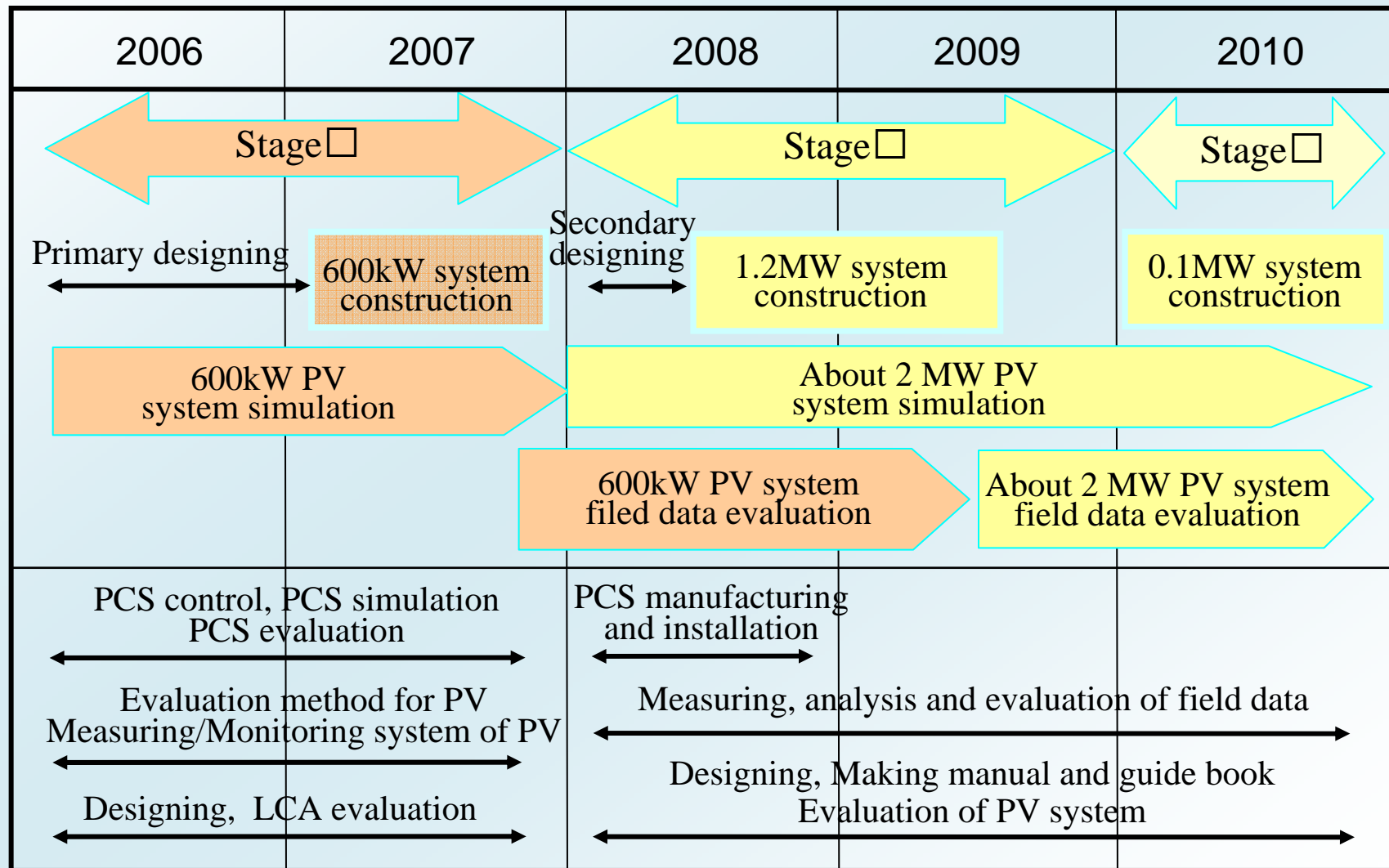
To Tokyo

Mega-solar PS

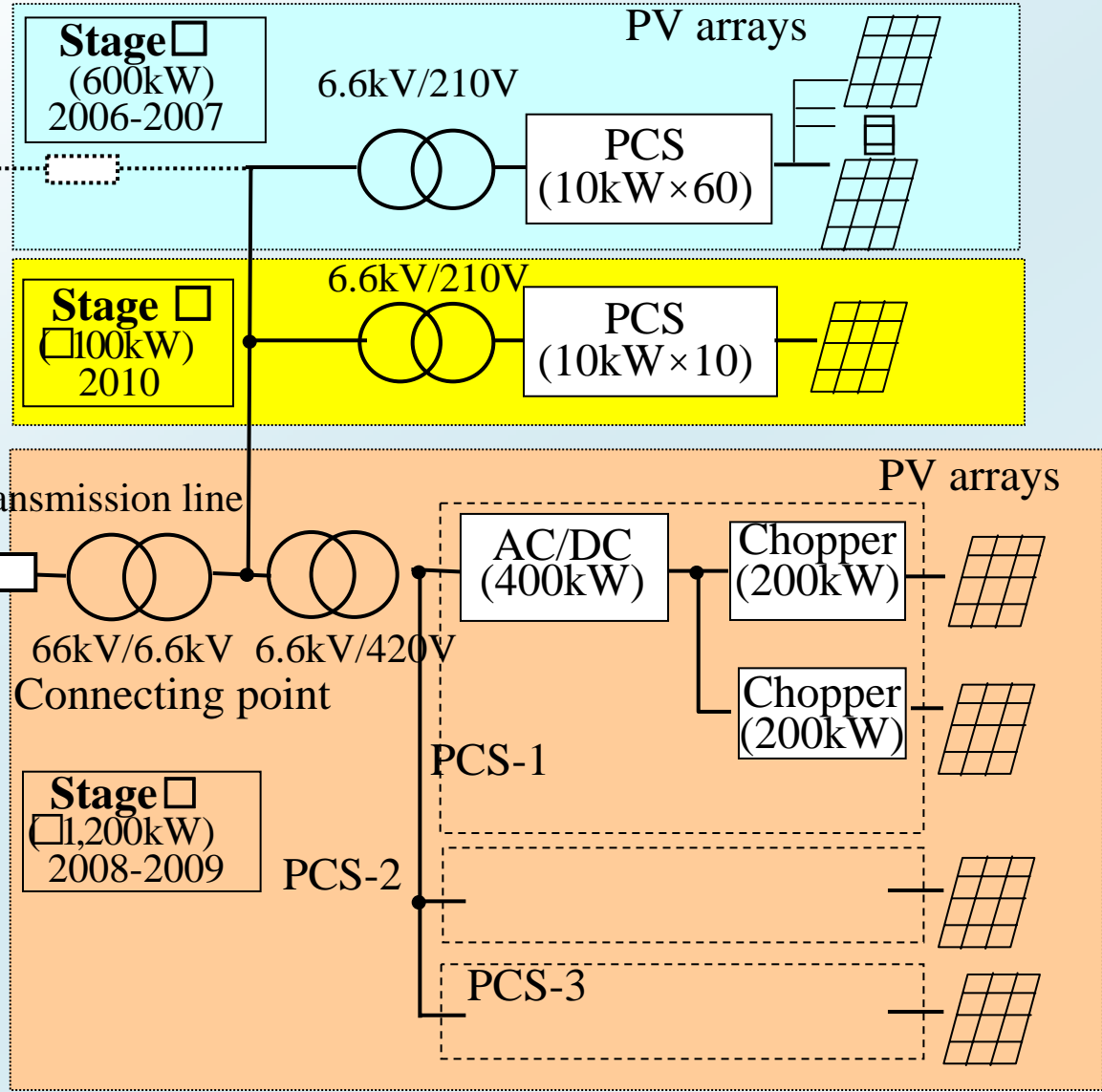
- Hokuto City**
- Birth: March 2006
- Population: 50,000 people
- Area: 602.89km²
- Feature: Sightseeing and agriculture
Rich nature

Location of HMP

System installation and research schedule in HMP



Change line connection from 6.6kV to 66kV in 2009

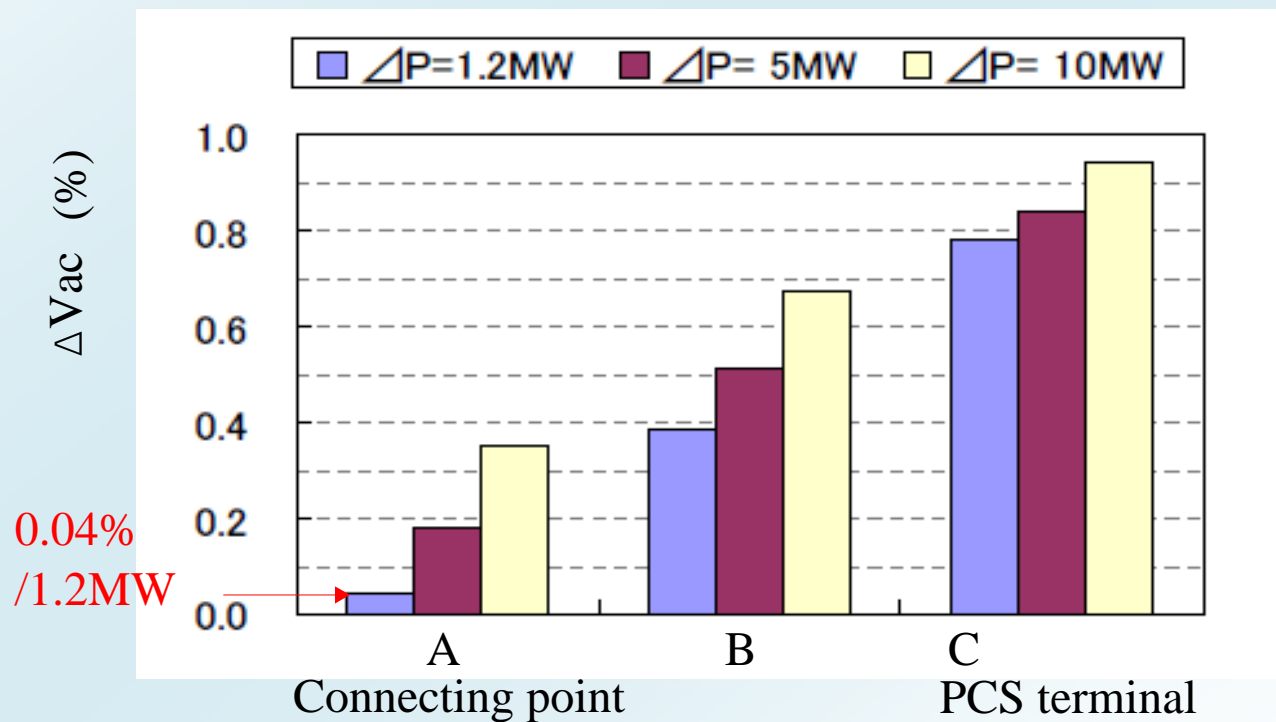
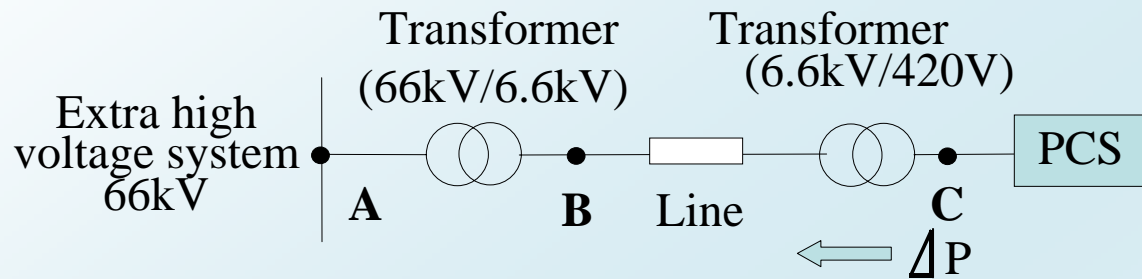


Whole system configuration of HMP

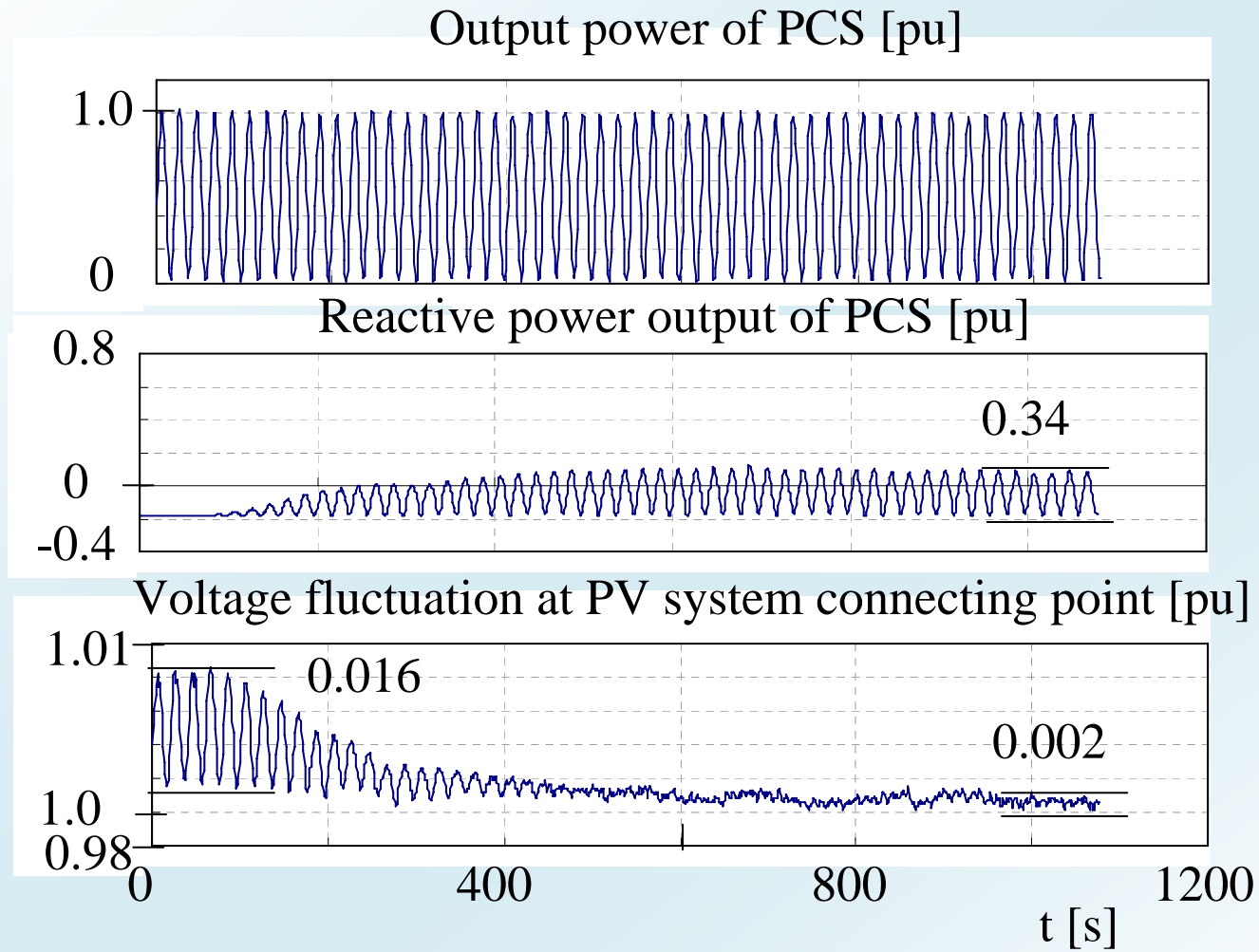
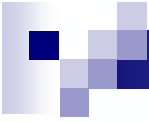
Large-scale power conditioner

Specifications and developing targets of 400kW PCS

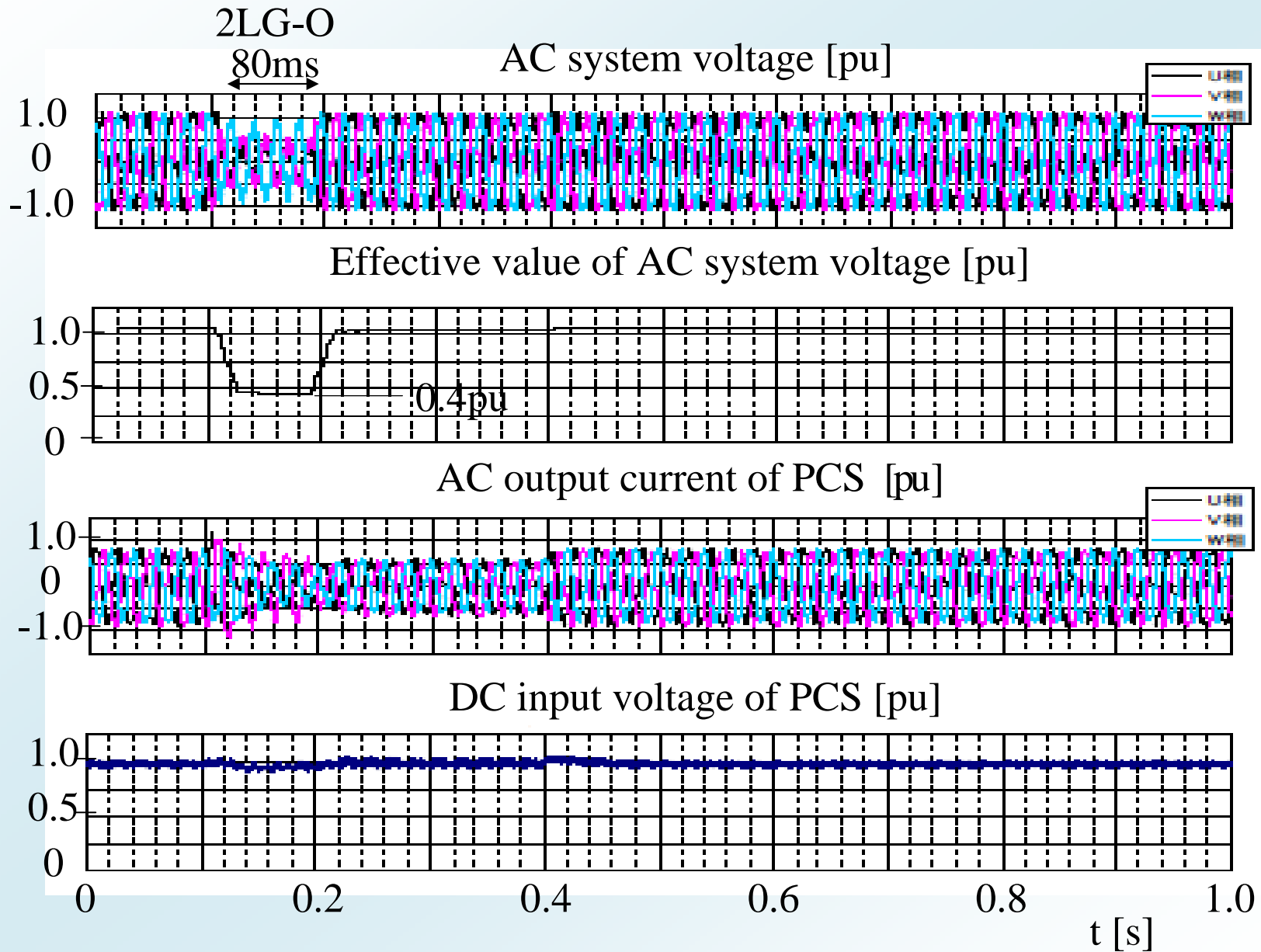
Capacity	400kW
AC voltage	420Vac \pm 10%
Max. permissible DC voltage	600Vdc
Input DC voltage	230-600Vdc
Switching freq.	4 kHz
Conversion efficiency	> 95 % from 30-100% output
Control functions	/ MPPT by choppers
	/ Suppression of Δ Vac \leq 2%
	/ Low voltage ride-through \leq 60%, within 200ms
	/ Suppression of low-order harmonics \leq 80% of the guide-line



Simulation results of voltage drops due to PV generation output



Analogue model test of Voltage fluctuation suppression by PCS
due to PV generation output fluctuations

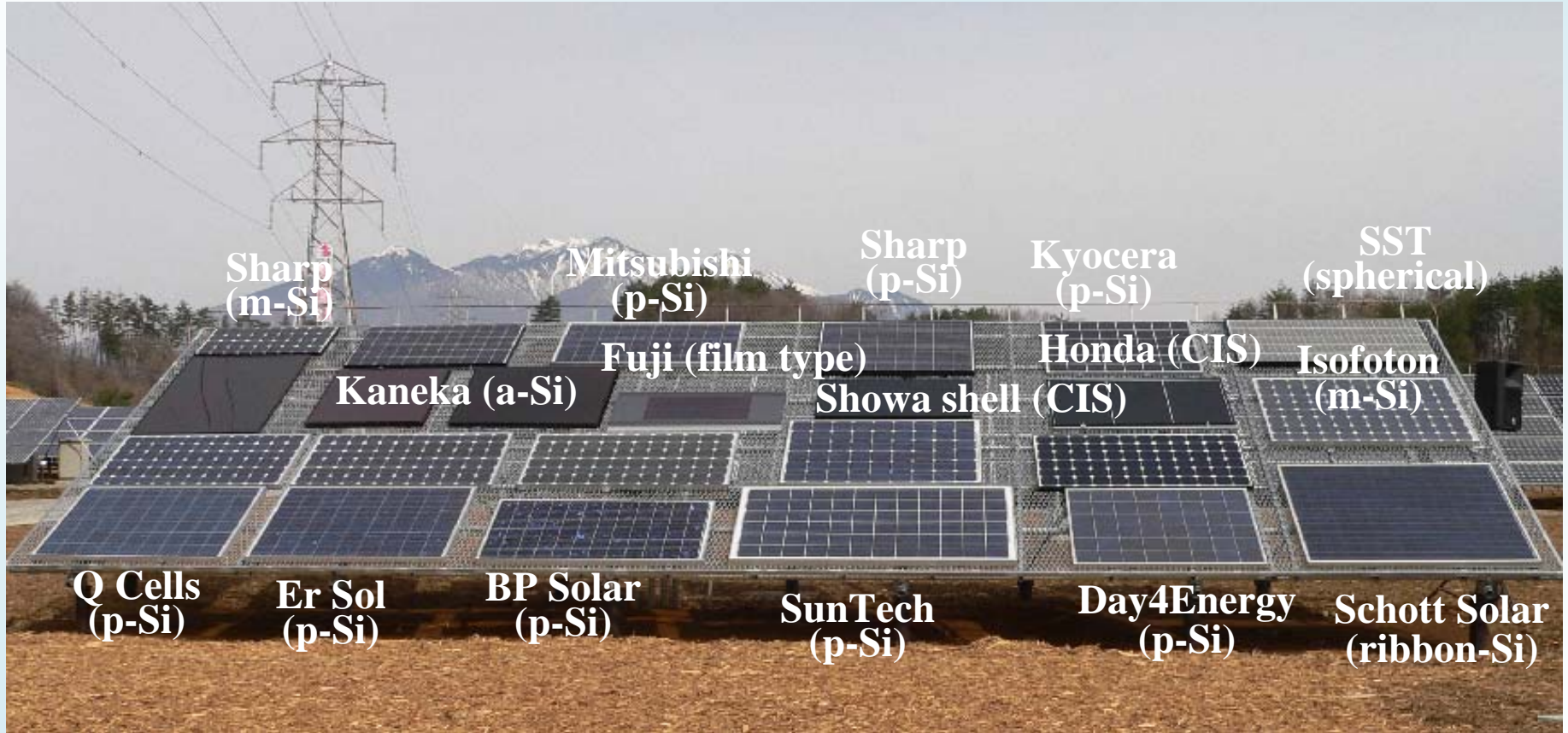


Analogue model test of PCS when 2LG-O fault occurred in AC system 12

PV modules

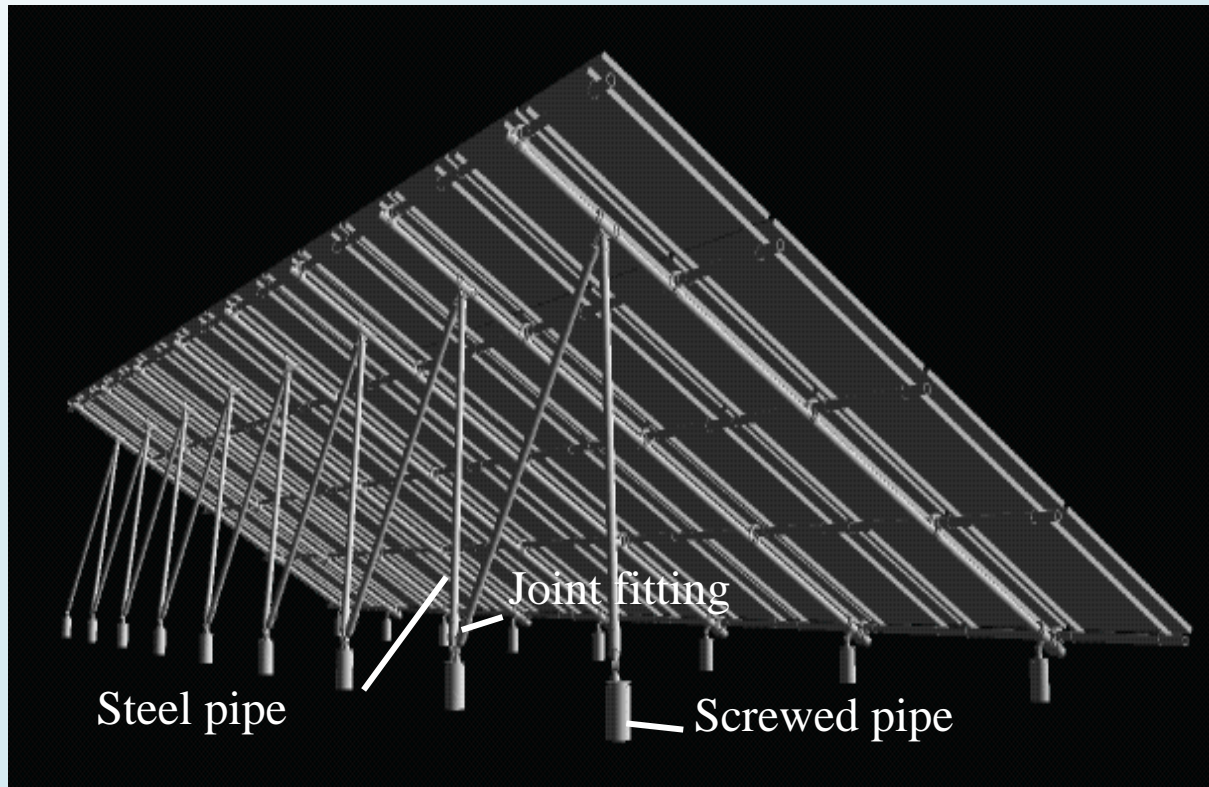
Selected advanced type PV modules and systems in 1st stage

Classification	Manufacture	Installed Capacity (kW)	Remarks
Mono-crystal Si	Sharp	30	High efficiency
	Sanyo	30	High efficiency
	Isofoton	30	Large area
	GE-Energy	30	Chemical processing
	Sun Power	50	Back wiring
Poly-crystal Si	Sharp	30	High efficiency
	Kyocera	100	High efficiency
	Mitsubishi	30	Tandem, High efficiency
	Sun tech	30	Large area
	Day4Energy	30	No bus-bar
a- Si	Kaneka	40	Single/multi- layer
Spherical	SST	20	Spherical concentrating
Ribbon Type	Schott Solar	30	Ribbon processing
CIS	Showa Shell	30	Compound Semiconductor
Tracking	Sharp	3×2	Concentrating & tracking



24 kinds of PV modules in 1st stage

Supporting structure



Supporting structure of PV module



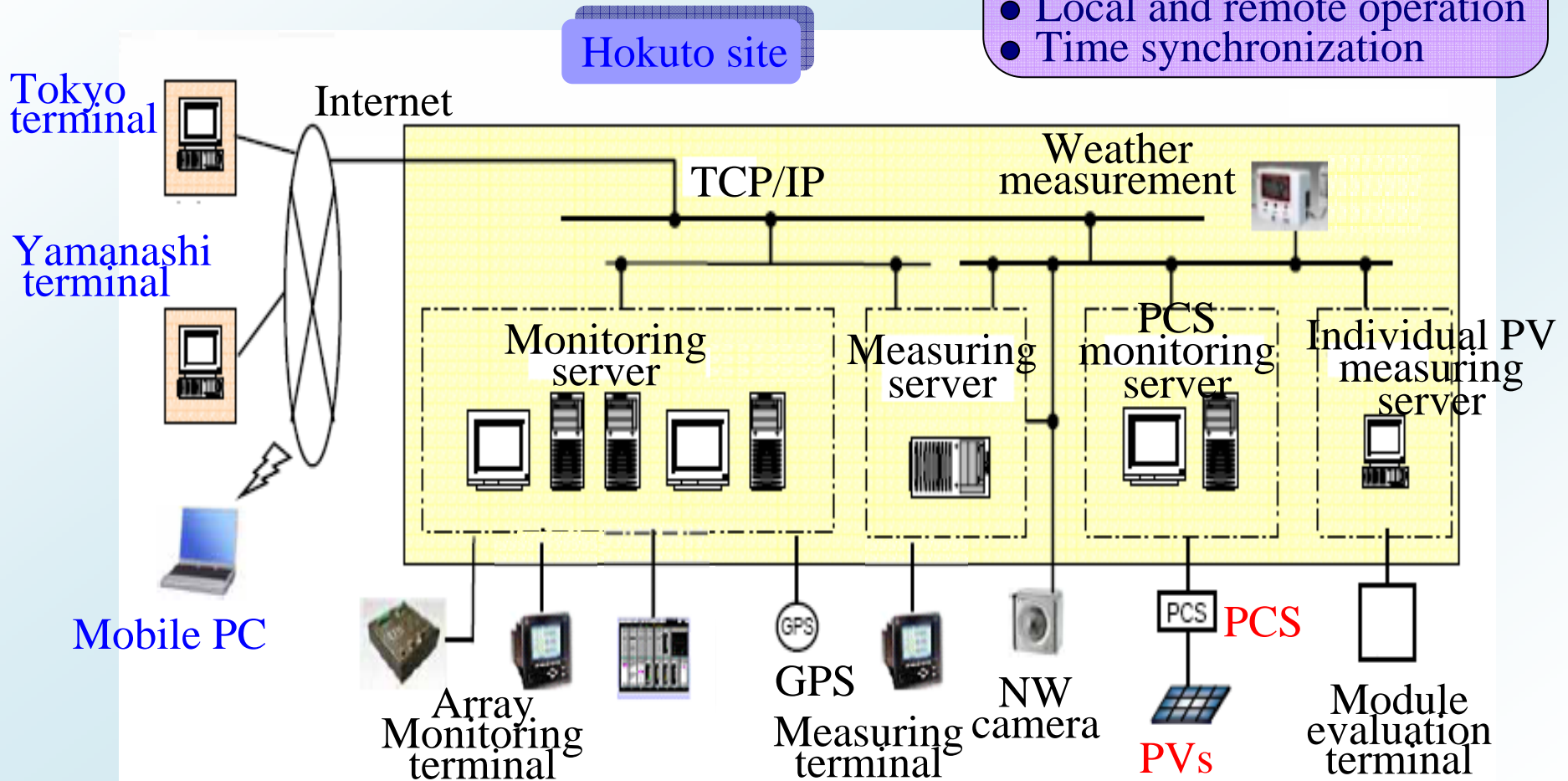
Fixed angle type

Tracking type

Hokuto site bird's-eye view

Characteristics

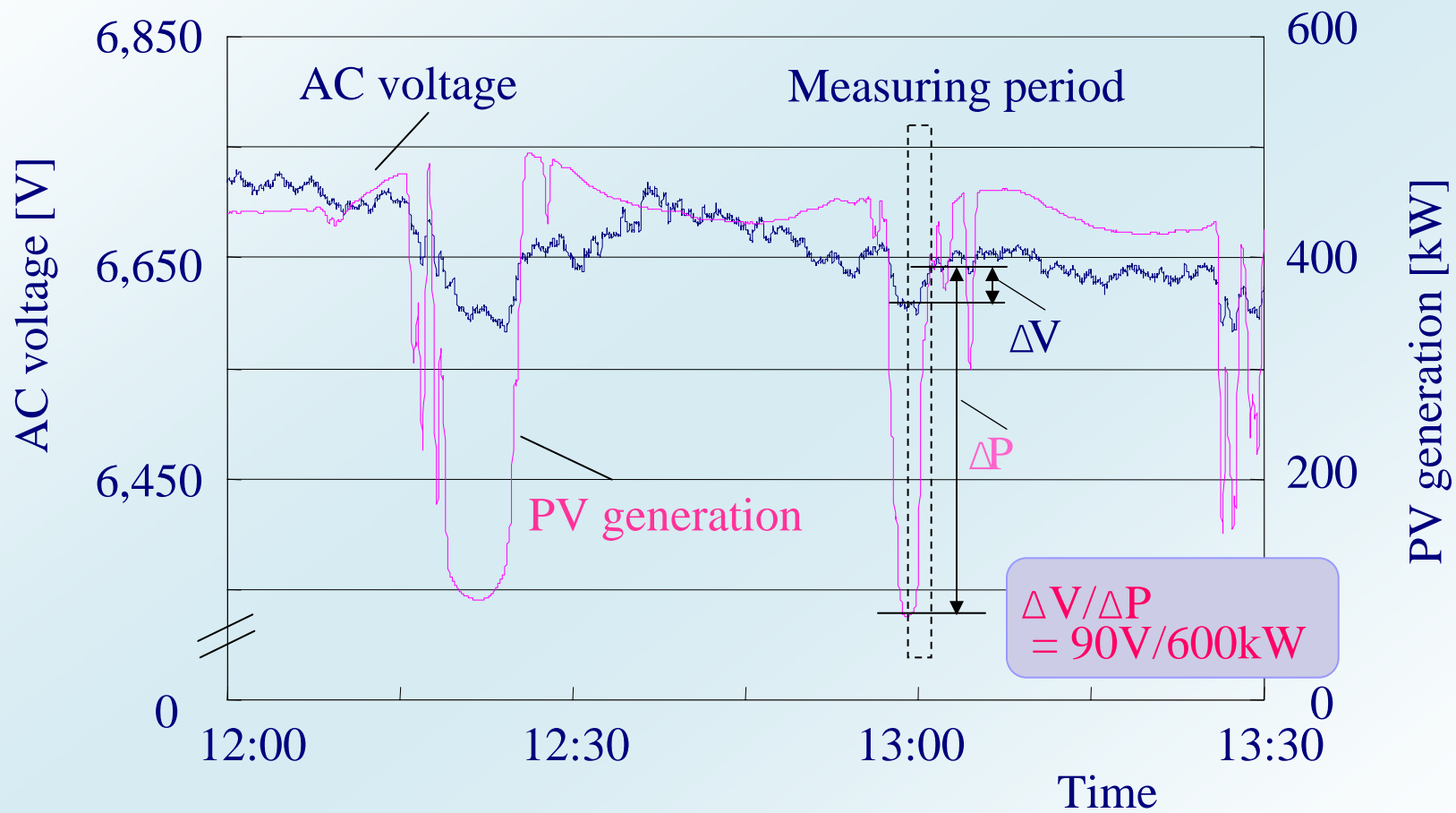
- Partly dual system
- Separation of measuring sys. and monitoring sys.
- Local and remote operation
- Time synchronization



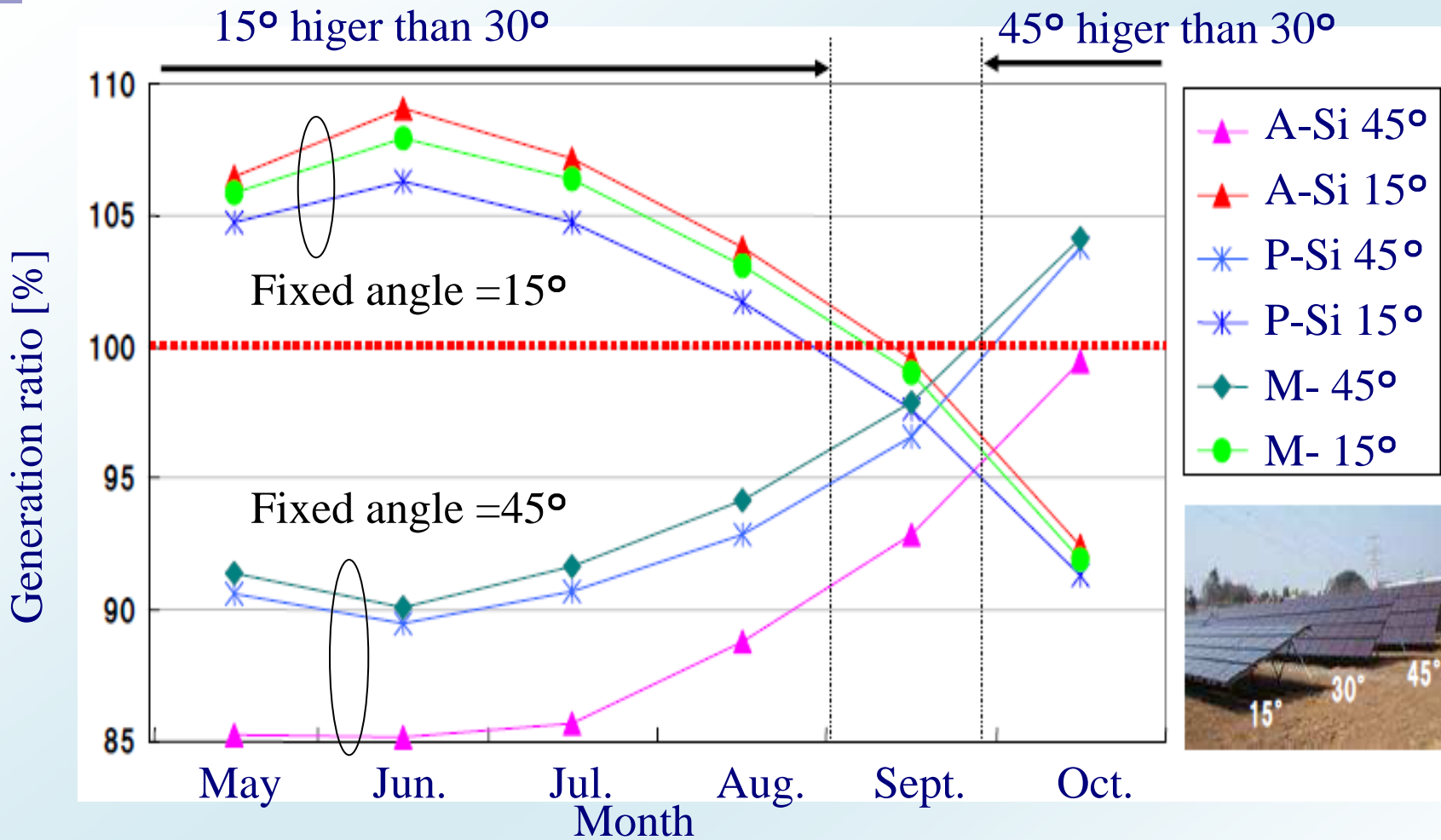
Configuration of measuring/monitoring system

Items of measuring/monitoring system (1st stage)

Measuring/monitoring items	Number of M/M points	Sampling time (s)	Remarks
DC voltage of PV array	70	6	
DC current of PV array	70	6	
Generation output power of PV array	70	6	
PCS input/output power	2x70	6	
Harmonics voltage/current	2x70	60	Fundamental - 63 rd
AC voltage/current	2x4	6	210V/420V/6.6kV/66kV
Active /reactive power	2x4	6	↑
Frequency	1	60	
Power factor	1	60	
Irradiation	14	6	
Temperature	1	6	
Direction and velocity of wind	2	6	
Fault detection signal	7	-	Real time

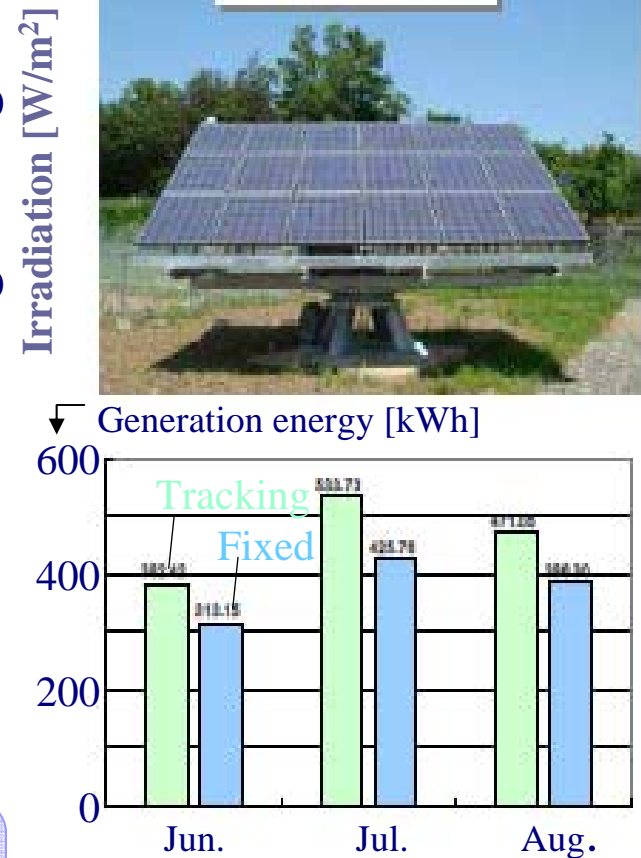
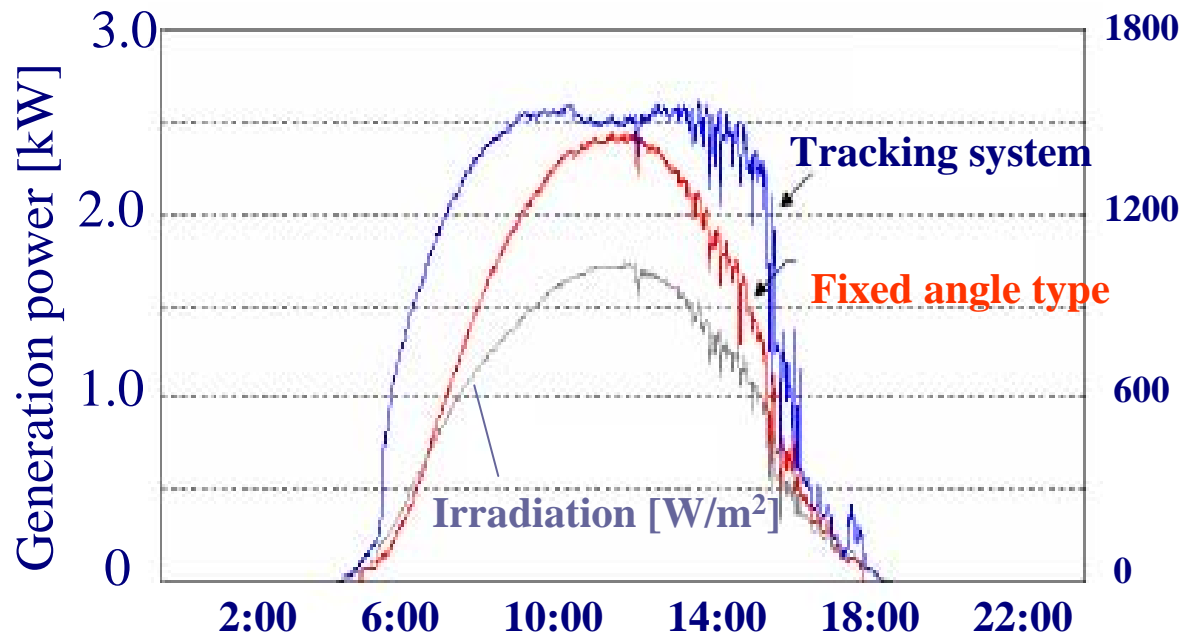


AC voltage fluctuations due to PV generation fluctuations



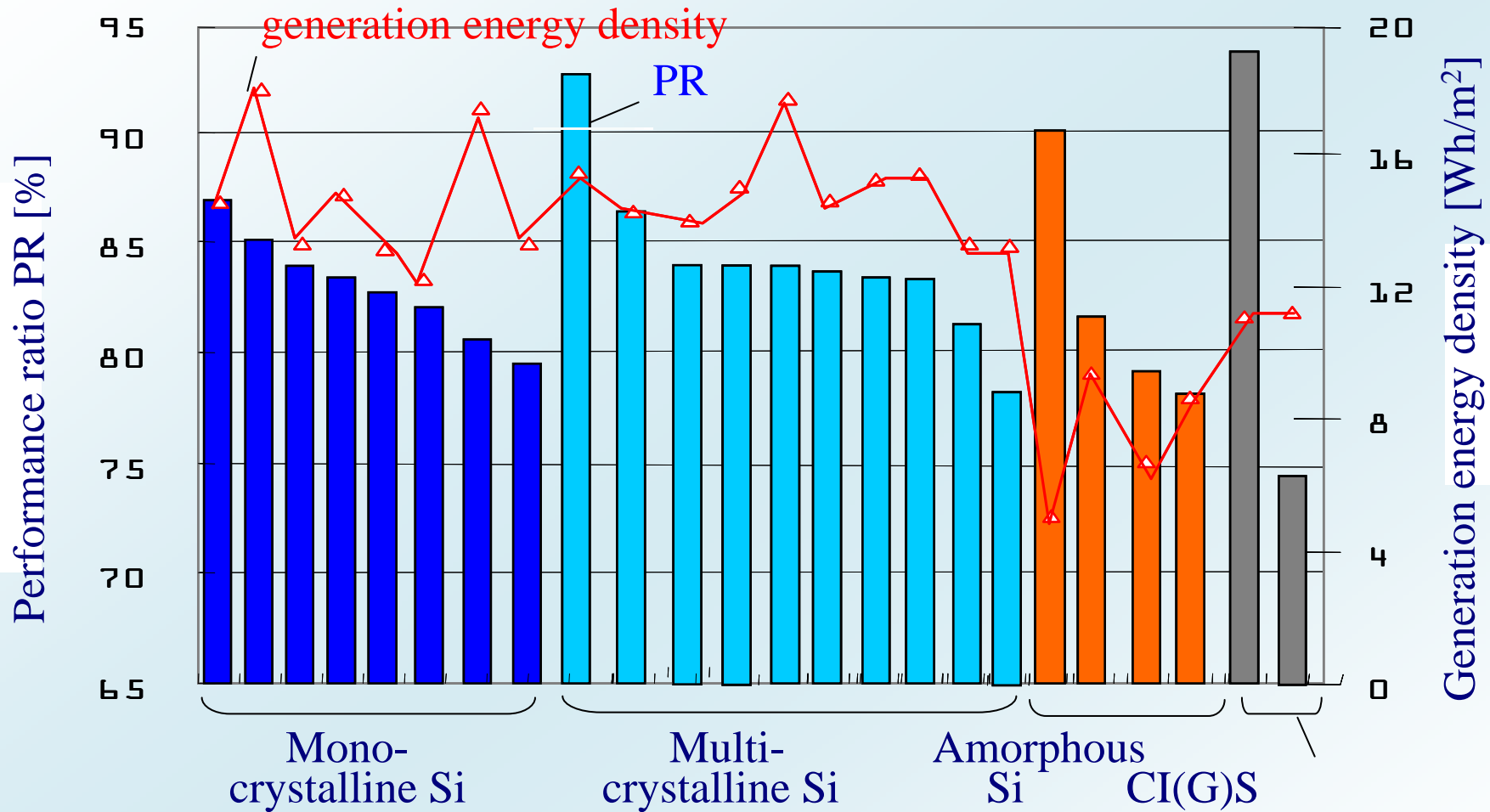
$$\text{Generation ratio}[\%] = \frac{\text{Cumulated generation of } 15^\circ \text{ or } 45^\circ [\text{kWh}]}{\text{Cumulated generation of } 30^\circ [\text{kWh}]} \times 100$$

Characteristics of inclination angle of array



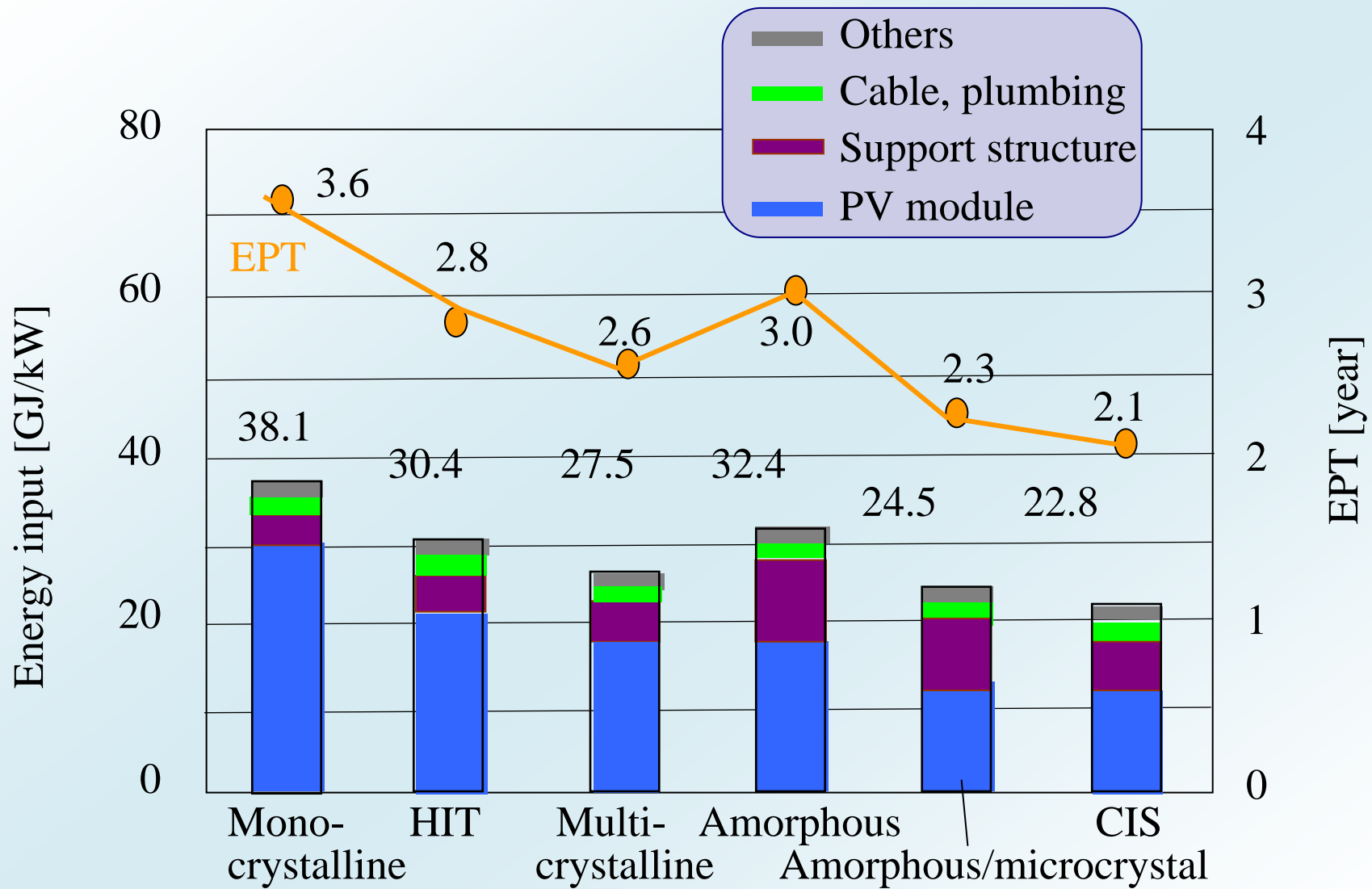
$$\frac{\text{Generation energy of tracking system}}{\text{Generation energy of fixed angle type 30}} = 1.23$$
 (Jun.-Aug. 2008)

Generation characteristics of tracking system
 (Measured Jun. 17 2008)



Measured performance ratio and generation energy density of PV modules
 (Measured data from Apr. to Dec. 2008)

PR= Generation output of PV[W]/ Rated capacity of PV[W]x100 [%]



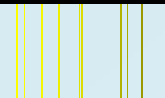
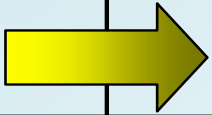

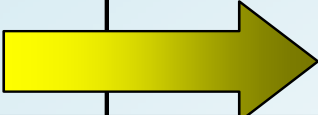
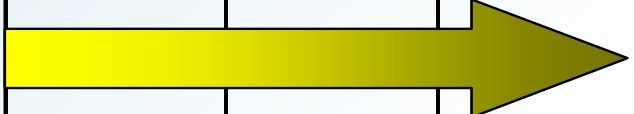
Calculated energy input and EPT of PV modules

CONCLUSIONS

- The outlines in Hokuto mega-solar project were introduced.
- Some results in the 1st stage were discussed.
- The 2nd stage have just started constructing.
The results will be shown later.

We thank to NEDO for research supports.

System Installation and Research Schedule Wakkanai Mega-solar Site

Fiscal Year		2006	2007	2008	2009	2010	
System Installation	PV Modules		80kW	2.0M W	4.0M W	5.0M W	
	NaS Battery			0.5M W	1.5M W		
	Electric Double Layer Capacitor					Pending	
	Connection to the Grid		66kV	33kV			
Research	Evaluation of PV Modules						
	Development of Output control system						
	Establishment of Output control system						

Verification Site

Location: Koitoi Wakkanai Hokkaido Japan

Wakkanai is the northernmost city in Japan. It is the symbol city of renewable energy because there are large wind-farms and this mega-solar station.

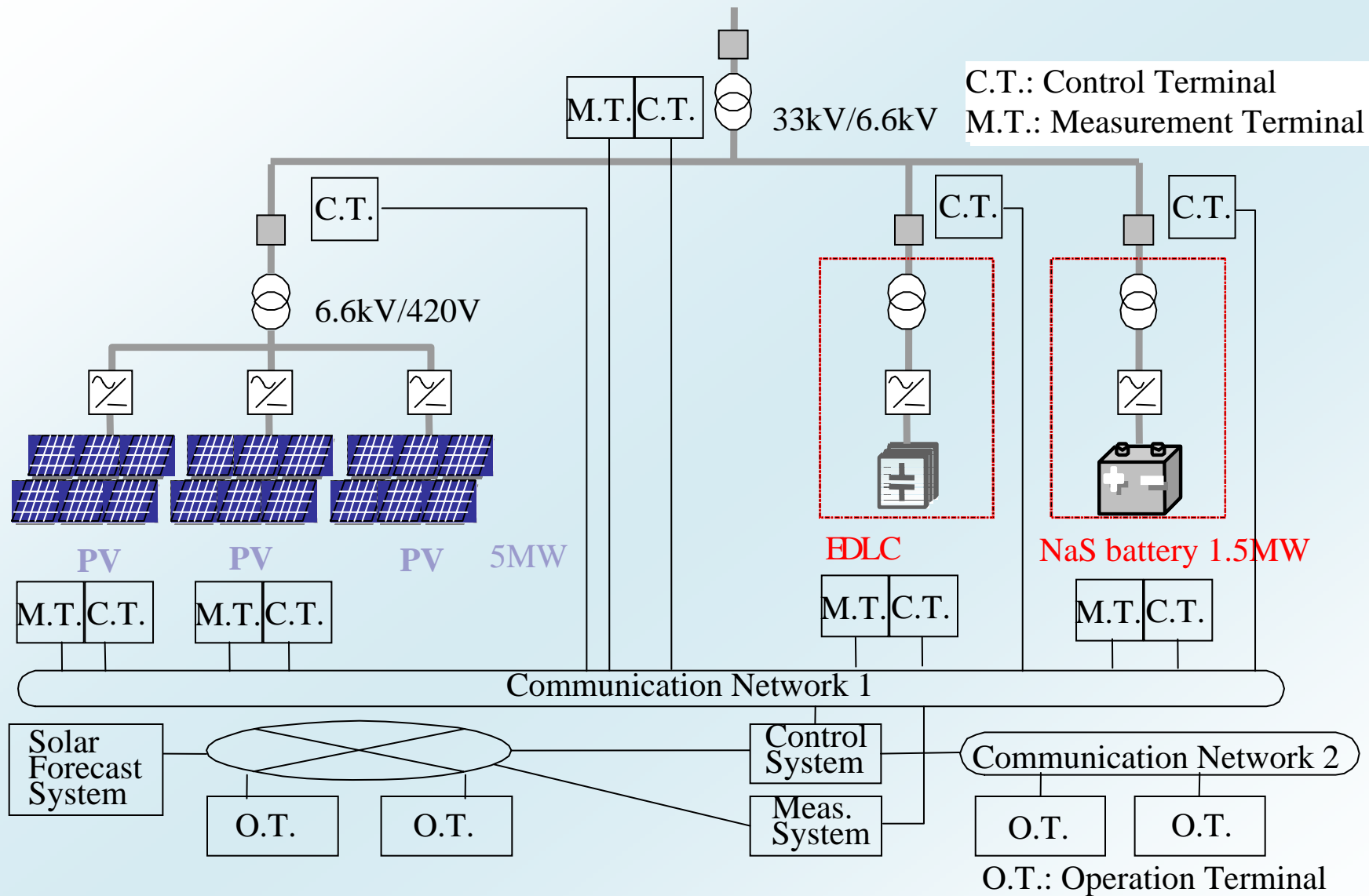
Annual solar energy in Wakkanai is about the same in Tokyo. (-4%)

Connection to the Grid: 33kV transmission line 5km

Japan is the islands country, so power systems are weaker than those of continents. We have to develop mega-solar power stabilizing technology. Connection to the weak power system will be good for this verification study.

Hokuto site is the brother site sharing the same project name.





Outline of Wakkanai PV power generation



4MW Installation at Wakkanai site (Jan. 2009)